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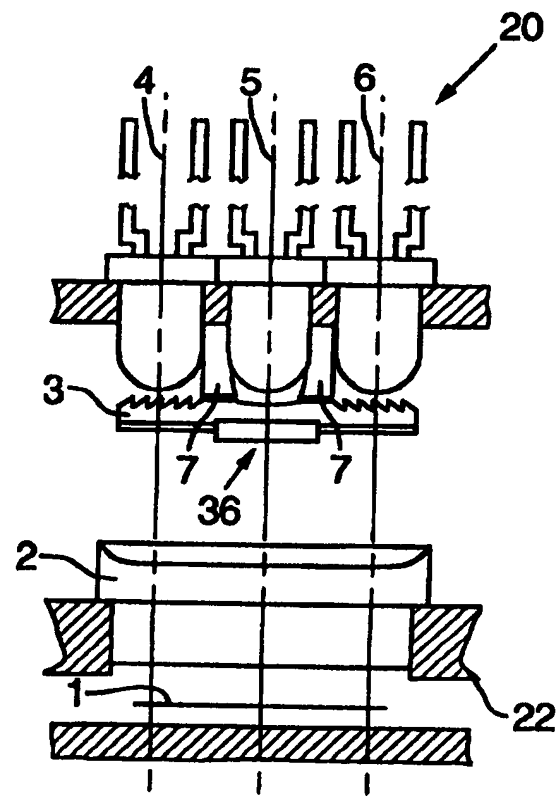
(54) Title: OPTICAL REFLECTION SENSING ARRANGEMENT FOR SCANNING DEVICES

(57) Abstract

The optical scanner uses a unique compound optical system for processing reflected radiation in a manner to reduce the variations caused by changing position of a scanned substrate in a guideway. Two sources of radiation are directed at similar angles to the surface to be screened and the radiation is distributed over a larger area. Changes in position of the substrate in the guideway change the actual area reflecting the radiation sensed by the sensor, but the size of the reflecting area does not appreciably change. Any change effects both radiation systems in a similar manner.



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TITLE: OPTICAL REFLECTION SENSING ARRANGEMENT FOR SCANNING DEVICES

FIELD OF THE INVENTION

The present invention relates to optical scanning arrangements and in particular relates to optical scanning arrangements where a substrate is scanned by two different radiation sources.

BACKGROUND OF THE INVENTION

A host of optical scanning arrangements are known where light from an LED or other source is directed to a bank note or other substrate which reflects the light and the reflected light is measured by a sensor. The sensor produces electrical pulses according to the reflected light. In some cases, surfaces are scanned to determine whether the particular surface is authentic. The substrate is scanned by two different light sources at different wavelengths and various tests can be carried out comparing the signal due to a predetermined relationship of the reflecting characteristics of the substrate to the two different types of radiation.

One of the problems with sensing arrangements of this type is fluctuations in the intensity level of the reflected radiation due to changing positions of the substrate relative to the emitter and sensor. As can be appreciated, the substrate, such as a bank note, debit card or other substrate, is moved in a guideway past the sensing arrangement. This guideway has tolerances, and thus, the separation between the substrate and the sensing arrangement can vary. Also, there can be changes in the angle of the substrate within the guideway which can also affect the intensity level of the reflected radiation from the substrate. Problems of this type are compounded by sensing arrangements which use two different wavelengths of radiation, as changes in position do not always cause a similar change in each of the two systems even where the systems share the same photo sensor.

SUMMARY OF THE INVENTION

An arrangement for scanning a substrate as it is moved through a scanning region comprises a light emitter which emits radiation, an optical lens which processes the emitted radiation to form a distributed band of radiation having a similar direction and intensity within the distributed band, a guideway for receiving a substrate to be scanned, the guideway being orientated relative to the distributed band of radiation to move the substrate through the band of radiation illuminating a strip of the substrate to the radiation, the radiation striking the substrate at a generally acute angle and causing the substrate to reflect the radiation according to the characteristics of the substrate with the reflected radiation being sensed by a photo sensor. The photo sensor is generally isolated from directly receiving radiation from the light emitter and only receives radiation from a portion of the illuminated strip. The location of the portion of the illuminated strip changes as changes in the separation distance of the substrate and the sensor occur due to tolerances of the guideway while the radiating areas of the portion remains generally constant. With this arrangement, changes in the separation, distance or the angle of the substrate within the guideway itself does not appreciably affect the amount of sensed radiation, as the radiation has been processed to form a distributed band of generally constant distribution and intensity and only using a portion of this distributed band for receipt by the photo sensor. Changes in position change the position of the portion of the radiation which is used, however, the net effect remains much more consistent.

According to an aspect of the invention, a second optical lens is provided which focuses the distributed band of radiation prior to striking the substrate to effectively narrow the width of the distributed band.

According to yet a further aspect of the invention, the photo sensor has an associated optical focusing

arrangement located to focus reflected radiation from the portion of the distributed band onto the photo sensor.

According to yet a further aspect of the arrangement, the second optical lens and the associated optical focusing arrangement of the photo sensor are integral.

An arrangement for scanning a substrate as it is moved through a scanning region, according to the present invention, includes an optical arrangement comprising a first light emitter which emits radiation at a first wavelength, a second light emitter which emits radiation at a second wavelength, an optical lens for each emitter which processes the emitted radiation to form a common distributed band of radiation where the radiation from each emitter has a similar direction and intensity within the distributed band and the intensity within the distributed band for the respective wavelengths are generally known and related in a fixed manner. A guideway receives a substrate to be scanned and allows movement of the substrate through the guideway. The guideway is orientated relative to the distributed band to move the substrate through the distributed band exposing a strip of the substrate to radiation from each emitter which impinges on the substrate at an acute angle and causes the substrate to reflect according to the characteristics of the substrate, which reflected radiation is sensed by a photo sensor. The radiation sensor is generally isolated from directly receiving radiation from the light emitters and only receives radiation from a portion of the distributed strip. The location of the portion of the narrow strip changes as changes in the separation distance of the substrate and the sensor occur due to tolerances of the guideway, while the radiating area of the portion remains generally constant. With this arrangement, the distributed radiation minimizes the anticipated changes of the position of the substrate within the guideway. Increased accuracy is obtained as there are less fluctuations in the measured intensity and changes occur generally equally to both systems.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are shown in the drawings, wherein:

Figure 1 is a partial side view showing the optical sensing arrangement and the substrate to be scanned;

Figure 2 is a view of Figure 1 taken along line A-A;

Figure 3 is a top view taken along line B-B of Figure 2;

Figure 4 is a view of the arrangement showing the field of view of the sensor;

Figure 5 shows the side view of Figure 4;

Figure 6 illustrates the processing of the radiation from an LED to produce the desired radiation field on the substrate;

Figure 7 is a side view of the processing arrangement; and

Figure 8 is an enlarged view of the angled rear surface of the optical lens arrangement having a series of angled surfaces.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The optical reflection sensing arrangement 20 scans a substrate, generally shown as 1, as it passes through the guideway 22. The direction of travel of the substrate is indicated as 24. With this movement, a narrow band of the substrate is exposed behind the thick cylindrical lens shown as 2.

The optical reflection sensing arrangement 20 includes a first LED 4 which emits radiation of a first wavelength and a second LED, generally shown as 6, which emits radiation of a different wavelength. These LED's are aligned across the direction of travel 24 and a photo sensor 5 is located between the LED's. Blinds 7 are provided either side of the photo sensor such that direct radiation from either of the LED's cannot impinge upon the photo sensor 5. Emitted light radiation from each LED is generally spherical, however, a complex optical lens 3 is provided in front of the LED's and processes the radiation

in a particular manner. Figure 6 clearly shows how the emitted radiation, generally shown as 26, strikes the series of angled surfaces, generally shown as 14, and cause deflection of the emitted radiation producing the distributed radiation field, generally shown as 28. This radiation field has radiation of a similar angle and has distributed the radiation in a particular manner to provide more even intensity distribution along the exposed portion of the substrate, generally indicated as 30.

A second lens, this being the thick cylindrical lens 2, receives this radiation and as shown as Figure 7, again focuses the band of radiation into an area of reduced width. This is generally shown at position 32 in Figure 7. The radiation emitted by the LED 4 is similarly treated, however, it is angled in the opposite direction, and thus, exposes a similar area 30 on the substrate. Thus, the radiation from each of the LED's has been distributed in a particular manner and has been focused to expose a band on the substrate to the radiation. The intensity of the radiation over the distributed area 30 is similar.

The complex optical lens 3 includes a center section, generally shown as 36, which receives the radiation reflected from the substrate. It receives radiation from the substrate of the wavelength of the radiation from the LED 4 as well as of the wavelength of the radiation from the LED 6. The reflected radiation is generally shown in Figures 4 and 5 where the reflected radiation, indicated as 42, is focused by lens 2 and is focused a second time by the optical component 37 provided in front of the photo sensor 5. This tends to concentrate the reflected radiation on the photo sensor and generally regroups the distributed radiation.

As can be appreciated, the position of the substrate 1 within the guideway 22 is subject to tolerance variations and this would normally lead to substantial changes in the intensity of the sensed radiation. In contrast to prior devices, the photo sensor 5 only views a limited portion of the band on the substrate and changes in

position of the substrate merely alter the part of the band from reflected radiation is received by photo sensor 5. Changes in position affect both systems in a similar manner. The photo sensor is not as subject to wide variations in the intensity due to changes in the separation distance due to the distribution of the radiation on the substrate and the fact that the LED's produce overlapping bands of distributed radiation, and thus, changes in position are not as critical.

In addition, changes in the angle of the substrate within the guideway do not appreciably affect the intensity, as the field has been distributed along a larger area and this arrangement is not as sensitive to changes in the position of the substrate.

From the above, it can be seen that the optical reflection sensing arrangement has two identical illuminating system and one photo sensor. These identical illuminating systems and the photo sensor share certain optical elements. With this arrangement, identical fields of vision in both spectral bands is possible and improved independence of the signal from the distance between the substrate and the sensor is achieved. In addition, improvements in the independence of the signal from the bank note turning angle is also achieved, as is independence of the signal from possible variation of the optical characteristics of the optical devices, the indicatrix of the illuminants and the photosensitive areas as well as possible departures of sensor optics.

From the above description it can be seen that the lighting distribution from each LED provides a particular form of distributed radiation and the distribution of the lighting from each of the LED's is similar. In this way, consistency between the effects of the radiation of each LED is possible and greatly improved with respect to prior art structures. The solution presented in the present case is a combination of using a field of vision of the photo sensor which is relatively low while illuminating areas which are relatively large to provide sufficient uniform

field of vision lighting from each LED. The limited field of vision of the photo sensor is the result of focusing of the photosensitive area of the photo sensor on the bank note surface in the meridian perpendicular to the alignment line of the optical devices. In addition, the original divergence angle of the field of vision is limited in the other meridian via opaque blinds 7. The focusing is achieved with two cylindrical surfaces, these being the upper part of the lens 2 and the center of the lower surface of the complex optical lens 3. Some narrowing of the field of vision in the plane of the bank note caused by blind 7 can be made for by the cylindrical form of the optical part 3 facing the photo sensor surface. This cylindrical form can either be concave or convex, depending upon whether the use of the usage of the blinds result in smaller or larger lengths of field of vision as compared with the target value. With the present structure, the whole field of vision of the photo sensor is evenly illuminated, and thus, the sensor range of sensing equals the field of vision.

With a substrate coming nearer or moving away, the field of vision is somewhat widened in one meridian because of the defocusing and alternately shrinks or expands in the other meridian because of the divergence of the border beams of the field of vision.

Even lighting is assured, as the light flux from each LED is spread over an area considerably bigger than the field of vision of the photo sensor, both in its width and length. In this way, the photo sensor field of vision is evenly illuminated, as it is basically scanning a smaller area and any changes in position still result in the same area being scanned and this area having the same even illumination. The degree of illumination tends to increase with a bank note coming closer and decreases when the bank note moves away as a result of the divergence of the light beam in one of the meridians. To make up for the decrease, the focusing of the beam in the other meridian is performed in a manner to make the beam shrink when the bank

note moves away. It means that the illuminant in this meridian is focused, not on the bank note surface, but on the surface located much further from the sensor. In the meantime, the particular location of the focusing surface is brought into conformity with the divergence to maintain the illumination in the working area more or less stable.

Different LED's may require different optical strengths of the total cylindrical optics. This value varies with the variation of curvature of the lower farthest cylindrical surface of part 3, as shown in Figure 3, where the lower surface of this part is shown. This principle of focusing simultaneously creates a relatively larger area of illumination, which is desired to keep the field of vision of the photo sensor evenly illuminated. The upper furthest surface of part 3 is a raster performing a number of functions at a time, these including deflecting the beams emitted by the LED in the direction of the illuminated area on the bank note, and correcting the energy distribution across the bank note surface in the meridian. To make these functions possible, the surface is provided with a number of teeth 14. Their working surfaces and set angles are selected depending on the nature of the original beams of the different LED's and the target characteristics of the system as a whole, such as dimensions, field of vision, etc.

It can be seen that the cylindrical lens 2 has an upper surface which focuses the light fluxes from the LED's and focuses the reflected light from the substrate. The lower flat surface is to plug a hole in the bank note guide. The usage of separate parts for focusing and plugging could lead to a dramatic increase in the light diffusion in the sensor.

The complex optical lens 3 has six independent surface areas. These surface areas include the two tooth-profiled sections which turn the light fluxes around and place them along the illuminated part of the bank note surface, a left lower area and a right lower area which are cylindrical in shape, but can be of other shapes to ensure

the correct positioning of the focusing plane of the illuminant of the LED's, and an upper central area which is cylindrical in shape with its axis perpendicular to the line along which all the optical devices are arranged. This upper central area can also be flat. This surface largely determines the length of the field of vision of the photo sensor. The lower central area is cylindrical in shape with its axis parallel to the line along which the optical devices are arranged. This surface ensures the right location of the focusing plane of the photosensitive area of the sensor.

The present optical reflection sensing arrangement reduces variations in intensity and variations in position of the substrate being scanned associated with other scanning arrangements.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An optical arrangement for scanning a substrate as it is moved through a scanning region, the optical arrangement comprising a light emitter which emits radiation, an optical lens which processes the emitted radiation to form a distributed band of radiation having a similar direction and intensity within the distributed band, a guideway for receiving a substrate to be scanned, the guideway being orientated relative to the elongate band of radiation to move the substrate through the band of radiation illuminating a strip of the substrate to the radiation which impinges on the substrate at an acute angle and causes said surface to reflect radiation according to the characteristics of the substrate which reflected radiation is sensed by a photo sensor, the photo sensor being generally isolated from directly receiving radiation from the light emitter and only receiving reflected radiation from a portion of the distributed band, the location of the portion of the distributed band changing as changes in separation distance of the substrate and the sensor occur as the substrate is moved through the guideway, however, the net effect of the reflected radiation on the photo sensor remains much more consistent.

2. An optical arrangement as claimed in claim 1 including a second optical lens which is elongate and serves to focus and thereby reduce the width of the distributed band.

3. An optical arrangement as claimed in claim 2 wherein the photo sensor has an associated optical focusing arrangement located to focus reflected radiation from the portion of the distributed band onto the photo sensor.

4. An optical arrangement as claimed in claim 3 wherein the second optical lens and the associated optical focusing arrangement are integral.

5. An optical arrangement as claimed in claim 4 wherein the light emitter is and LED which emits radiation of a specific wavelength.

6. An optical arrangement as claimed in claim 5 wherein the light emitter and the sensor are aligned across the direction of travel of the substrate.

7. An optical arrangement as claimed in claim 6 including a second light emitter which emits radiation at a wavelength different from the specific wavelength and the photo sensor receives radiation reflected from the portion from both light emitters.

8. An optical arrangement as claimed in claim 7 wherein the radiation from each light emitter forms a similar distributed band of radiation on the substrate with the intensity of each distribution being similar and not appreciably varying due changing position of the substrate in the guideway.

9. An optical arrangement for scanning a substrate as it is moved through a scanning region, the optical arrangement comprising a first light emitter which emits radiation at a first wavelength, a second light emitter which emits radiation at a second wavelength, an optical lens for each emitter which processes the emitted radiation to form a common distributed band of radiation where the radiation from each emitter has a similar direction and intensity within the distributed band and the intensity within the distributed band for the respective wavelengths are generally known and related in a fixed manner, a guideway for receiving a substrate to be scanned, the guideway being orientated relative to the distributed band

to move the substrate through the distributed band exposing a narrow strip of the substrate to the radiation from each emitter which impinges on the substrate at an acute angle and reflects according to the characteristics of the substrate which reflected radiation is sensed by a photo sensor, the photo sensor being generally isolated from directly receiving radiation from the light emitters and receiving radiation from a portion of the narrow strip, the location of the portion of the narrow strip changing as changes in separation distance of the substrate and the sensor occur as the substrate is moved through the guideway while the radiating area of the portion remains generally constant.

10. An arrangement as claimed in claim 9, wherein the light emitters and the sensor are aligned across the direction of travel of the substrate with the photo sensor intermediate the emitters.

11. An arrangement as claimed in claim 10 including a complex optical lens through which radiation passes from the emitters to the substrate or reflected from the substrate and directed to the photo sensor.

12. An arrangement as claimed in claim 11 wherein the complex lens includes two series of angled surfaces where each series produces the elongate narrow band of radiation from one of the emitters and wherein the distributed bands of radiation overlap at the substrate with each exposing the entire portion to the radiation.

13. An arrangement as claimed in claim 12 wherein the complex lens includes a focusing portion intermediate the two series of angled surfaces and the focusing portion concentrates the radiation reflected from the portion of the substrate onto the photo sensor.

14. An arrangement as claimed in claim 11 wherein said complex optical arrangement has a focal point for emitted radiation at a position beyond the position of the substrate in the guideway.

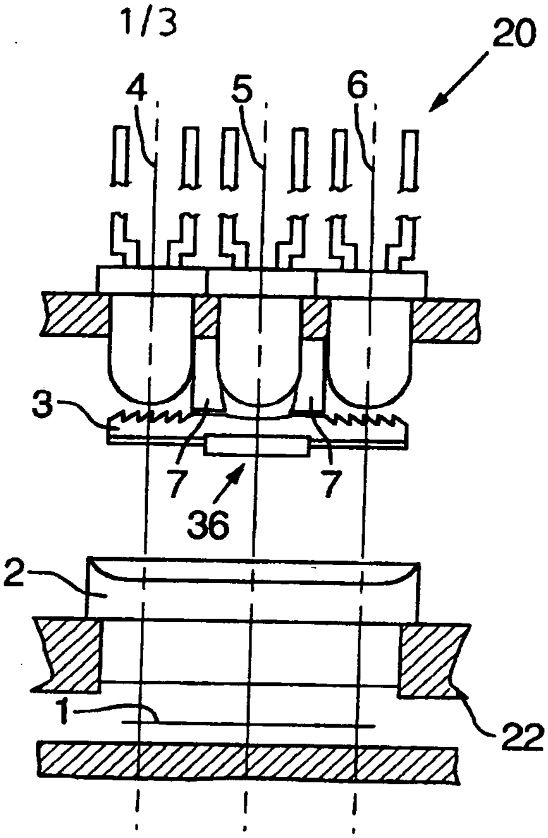

FIG.1

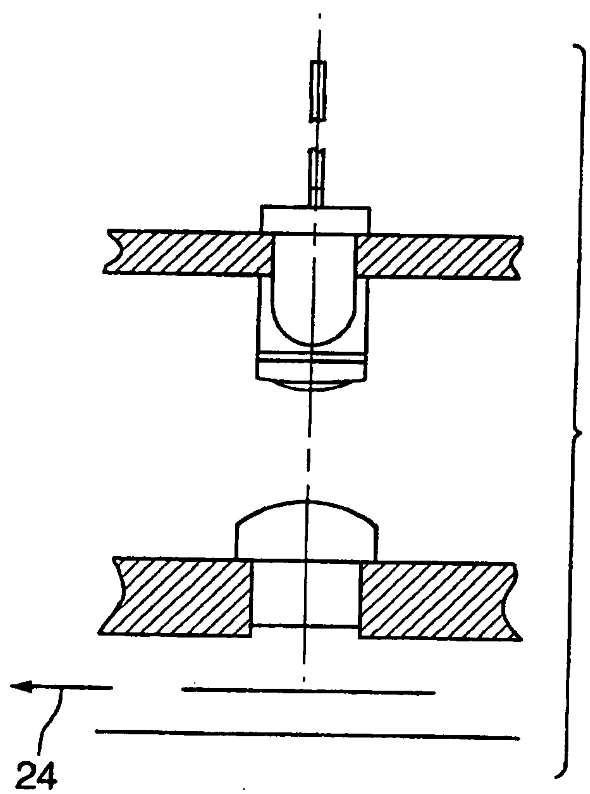

FIG.2

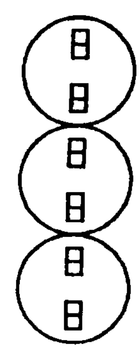

FIG.3

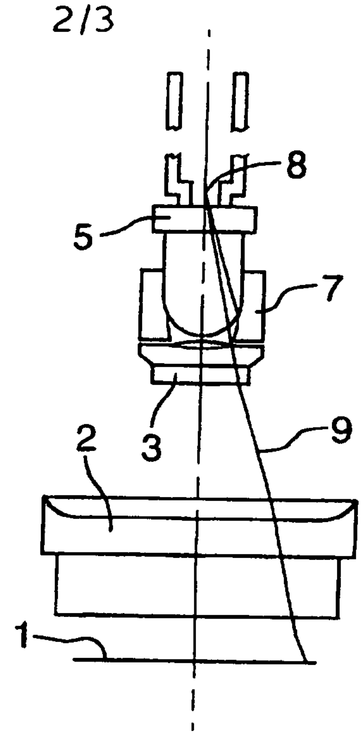

FIG.4

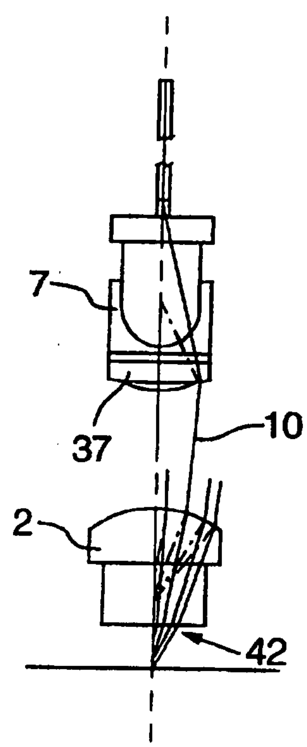

FIG.5

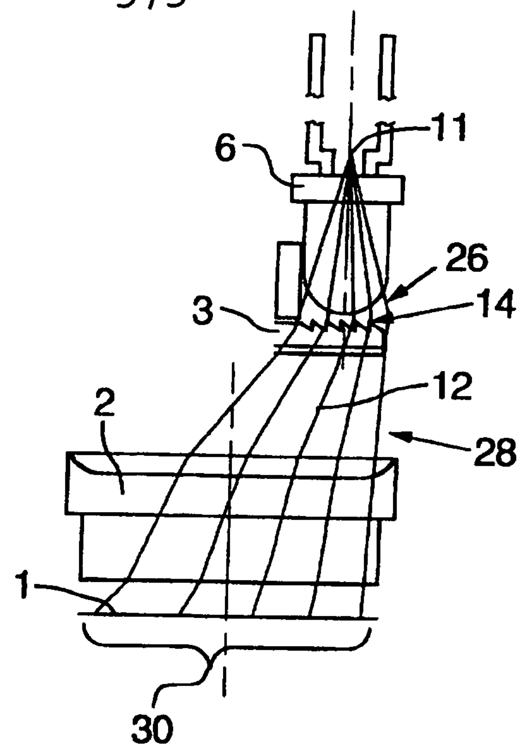

FIG.6

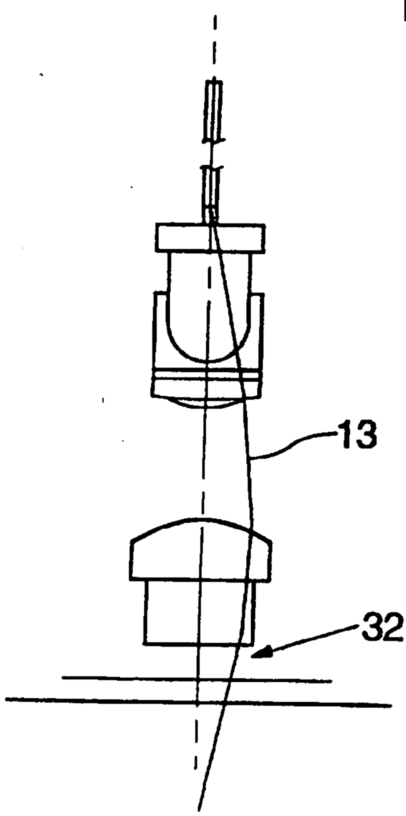

FIG.7

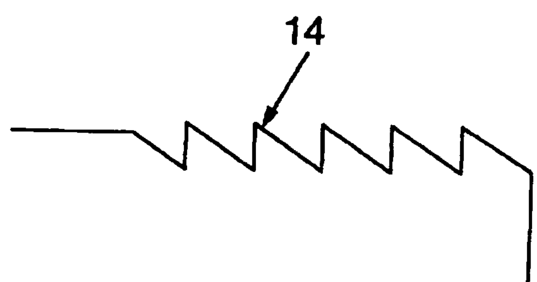

FIG.8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00104

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G07D7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G07D G07F G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	GB 2 225 659 A (WEST ELECTRIC CO) 6 June 1990 see the whole document ---	1-11
A	JP 59 099 237 A (KITA DENSHI:KK) 7 June 1984 see abstract; figures ---	1,9
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Date of the actual completion of the international search	Date of mailing of the international search report
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